Karyotypes of nineteen species of Fulgoroidea from China (Insecta: Homoptera)

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Abstract: The present paper deals with chromosome numbers, sex determination and chromosome behavior in 19 species of Chinese fulgoroids. Karyotype with 2n = 28(26 + XO) is suggested to be the ancestral type in Fulgoroidea. The relationship between Fulgoroidea and Hemiptera is very close because of sheathed testes and meiotic prophase Ⅰ with a typical diffuse stage in Fulgoroidea.

Key words: Fulgoroidea; karyotype; chromosome; meiosis

Karyotypes in Fulgoroidea were reported by Halkka (1957, 1959, 1960, 1964), Halkka and Heinonen (1964), Whitten (1965), Bhattacharya and Manna (1973), Parida and Dula (1981), Kuznetsova *et al*. (1998), etc., and 181 species belonging to 114 genera and 15 families have been karyotyped, which constitute about 2.4% of all known species (Kuznetsova *et al*., 1998).

Halkka (1959) suggested that the placement of the Fulgoroidea nearest to Sternorrhyncha was justified on the grounds of certain properties of the meiotic prophase. He argued that among the Auchenorrhyncha, the Fulgorina were characterized by the inclusion of a conspicuous diffuse stage in the meiotic prophase. Recently von Dohlen and Moran (1995), Campbell *et al*. (1995), and Sorensen *et al*. (1995) studied the molecular phylogeny of Homoptera and concluded that the Auchenorrhyncha were not a monophyletic group because the Fulgoroidea were very different from the other Auchenorrhyncha at the molecular level. In this paper male meioses in 19 species of Fulgoroidea from China were studied for the purpose of further revealing the taxonomic status of the Fulgoroidea.

1 Materials and Methods

Names and localities of the species observed are listed in Table 1. Specimens were fixed alive with alcohol and acetic acid mixture (3∶1) for 24 hours, stored in 70% alcohol at 4℃. Fixed specimens were dissected with a sharp needle under stereomicroscope. Testes of the fulgoroids are at the middle of abdomen above the alimentary channel, and each testis is covered with an orange or reddish orange sheath. Apical parts of the testicular follicles were squashed in 45% acetic acid, cover-slips removed after being frozen, air dried, and stained with phenol fuchsine. To determine chromosome number, at least 30 cells at meiosis metaphase Ⅰ were counted (Tian *et al*., 2004).

2 Results

Chromosome behaviors during the first meiosis in the male of fulgoroids are different from those in Cicadoidea, Cercopoidea, Cicadelloidea and Membracoidea (Figs. 1 – 22). The spermatocytes are much smaller at the beginning of the meiosis than later (Fig. 1). From leptotene to pachytene, the chromosomes show an obviously bouquet orientation, with sex chromosomes often linked with nucleolus. After the bouquet stage, spermatocytes are prominently increased in size at the diffuse stage, and chromosomes become invisible except sex chromosomes (Fig.2). The diffuse stage is a very peculiar character which also had been observed in Heteroptera and Sternorrhyncha, but its genetic significance remains unknown. After the diffuse stage, the chromosomes soon become visible again with almost completely terminalized chiasmata (Fig. 3), each bivalent possessing only 1 to 2 chiasmata. This stage is about equal to the diakinesis observed in the

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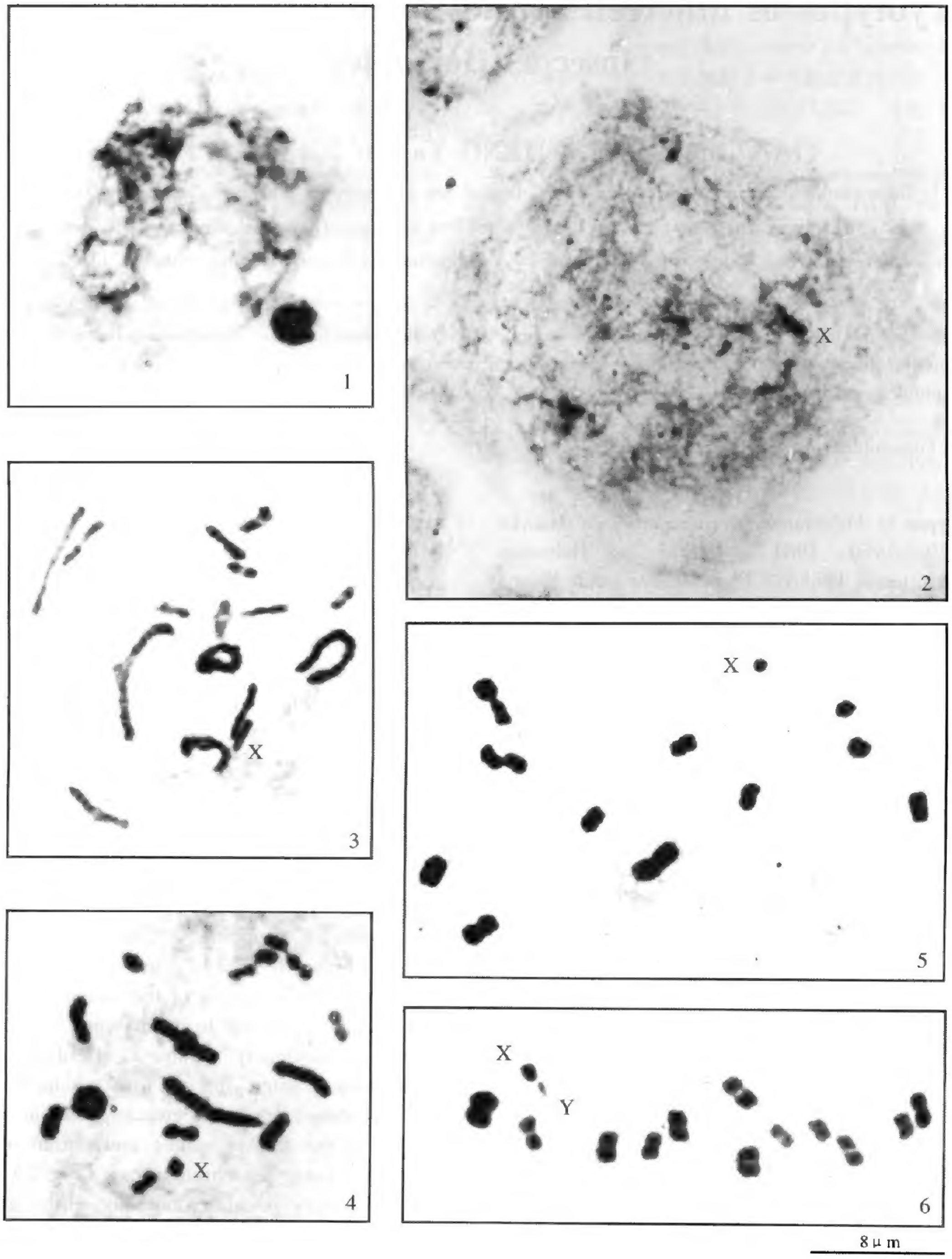
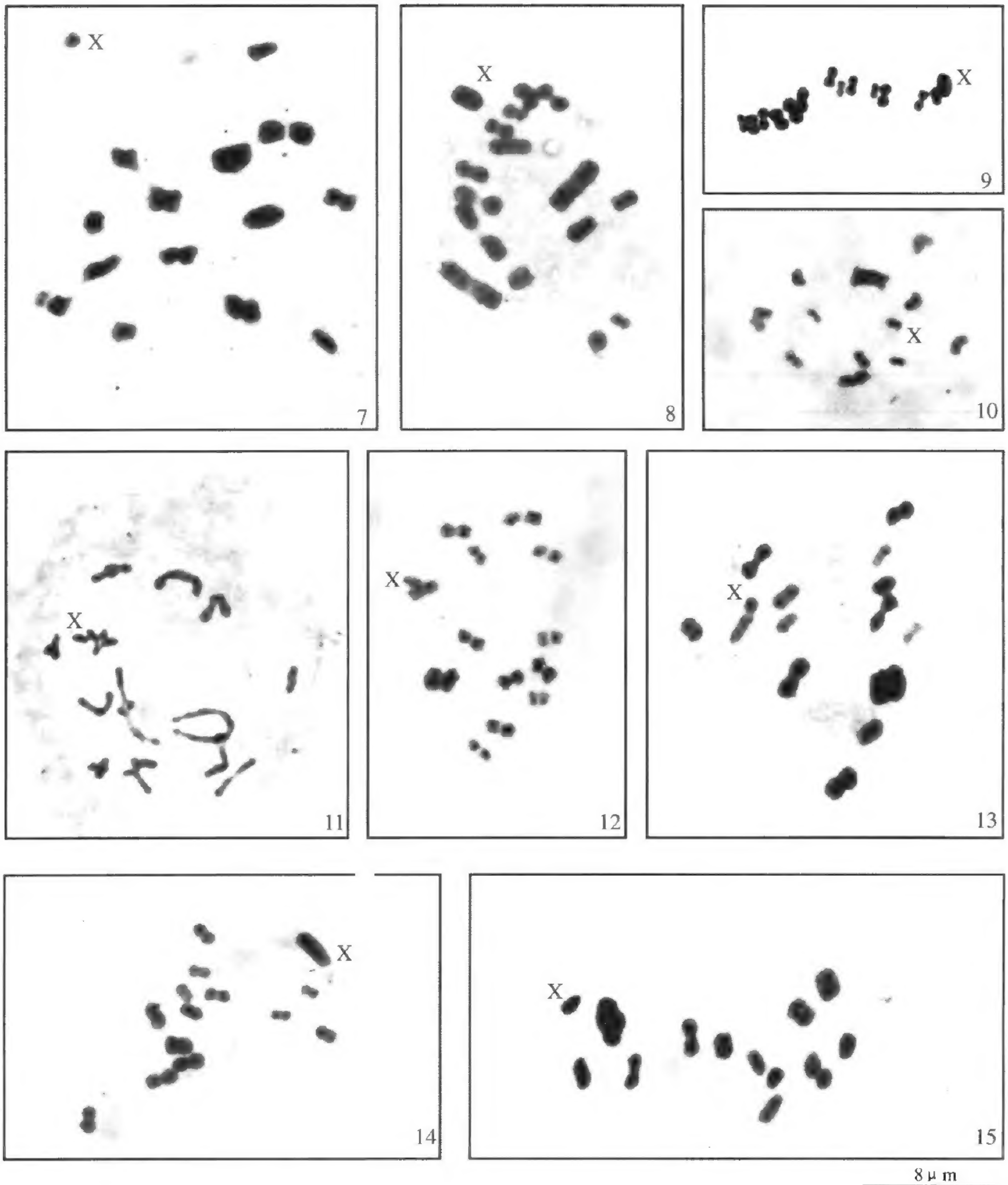


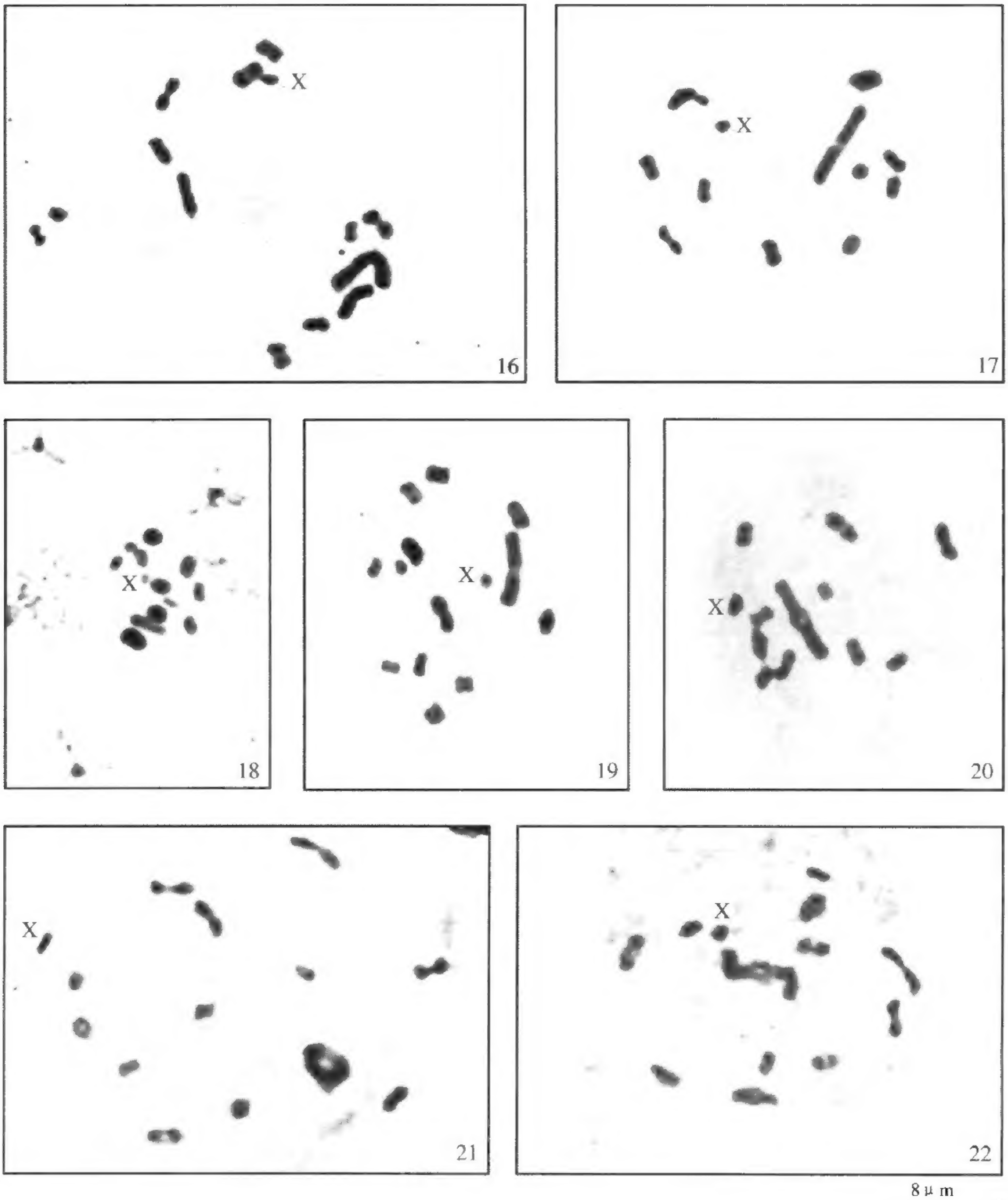
Figs. 1 – 6 Karyotypes in Fulgoroidea

1. *Oliarus apicalis* (Uhler), prophase Ⅰ; 2. *Oliarus apicalis* (Uhler), diffuse stage; 3. *Oliarus apicalis* (Uhler), diakinesis; 4. *Oliarus apicalis* (Uhler), metaphase Ⅰ, n = 16, XO; 5. *Magadha flavisigna* Distant, metaphase Ⅰ, n = 14, XO; 6. *Limois kikuchi* Kato, metaphase Ⅰ, n = 13, XY.



Figs. 7 – 15 Karyotypes in Fulgoroidea

7. *Oliarus insetosus* Jacobi, metaphase Ⅰ, n = 16, XO; 8. *Alina* sp., metaphase Ⅰ, n = 16, XO;
9. *Terauchiana singularis* Matsumura, metaphase Ⅰ, n = 14, XO; 10. *Lycorma delicatula* (White), metaphase Ⅰ, n = 12, XO;
11. *Tambinia debilis* Stål, diakinesis, n = 14, XO; 12. *Saigona* sp., metaphase Ⅰ, n = 14, XO;
13. *Centromeria manchurica* Kato, metaphase Ⅰ, n = 15, XO; 14. *Dictyophara sinica* Walker, metaphase Ⅰ, n = 14, XO;
15. *Seliza ferruginea* Walker, metaphase Ⅰ, n = 14, XO.



Figs. 16 – 22 Karyotypes in Fulgoroidea

16. *Euricania fascialis* Walker, metaphase Ⅰ, n = 14, XO; 17. *Ricania marginalis* Walker, metaphase Ⅰ, n = 14, XO; 18. *Pochazia zizzata* Chou *et* Lu, metaphase Ⅰ, n = 13, XO; 19. *Pochazia pipera* Distant, metaphase Ⅰ, n = 14, XO; 20. *Catonidia sobrina* Uhler, metaphase Ⅰ, n = 12, XO; 21. *Sivaloka damnosus* Chou *et* Lu, metaphase Ⅰ, n = 14, XO; 22. *Salurnis marginella* (Guerin), metaphase Ⅰ, n = 13, XO.

males of other auchenorrhynchas (Tian and Yuan, 1997). In metaphase Ⅰ chromosomes arrange on the equatorial plate, and bivalents are in axial orientation. Chromosomes behaviors are similar to telocentromere chromosomes. Chromosome numbers can be easily counted at the stage of diakinesis and meiosis metaphase Ⅰ. Chromosome numbers and sex determination in the species observed are listed in Table 1.

Table 1 Localities and chromosome data of nineteen Chinese fulgoroids

Family and species	Localities	Chromosome number (n)	Sex determination	Figure no.
Cixiidae				
Oliarus apicalis (Uhler)	Yangling, Shaanxi	16	XO	1 – 4
Oliarus insetosus Jacobi	Yangling, Shaanxi	16	XO	7
Alina sp.	Jigongshan, Henan	16	XO	8
Delphacidae				
Terauchiana singularis Matsumura	Yangling, Shaanxi	14	XO	9
Dictyopharidae				
Saigona sp.	Longyuwan, Henan	14	XO	12
Centromeria manchurica Kato	Haopingsi, Shaanxi	15	XO	13
Dictyophara sinica Walker	Yangling, Shaanxi	14	XO	14
Fulgoridae				
Limois kikuchi Kato	Haopingsi, Shaanxi	13	XY	6
Lycorma delicatula (White)	Yangling, Shaanxi	12	XO	10
Tropiduchidae				
Tambinia debilis Stål	Jigongshan, Henan	14	XO	11
Ricaniidae				
Euricania fascialis Walker	Yangling, Shaanxi	14	XO	16
Ricania marginalis Walker	Yangling, Shaanxi	14	XO	17
Pochazia zizzata Chou *et* Lu	Yangling, Shaanxi	13	XO	18
Pochazia pipera Distant	Jigongshan, Henan	14	XO	19
Issidae				
Sivaloka damnosus Chou *et Lu*	Jigongshan, Henan	14	XO	21
Flatidae				
Seliza ferruginea Walker	Jigongshan, Henan	14	XO	15
Salurnis marginella (Guerin)	Leigongshan, Guizhou	13	XO	22
Achilidae				
Magadha flavisigna Distant	Taibaishan, Shaanxi	14	XO	5
Catonidia sobrina Uhler	Jigongshan, Henan	12	XO	20

3 Discussion

According to Kuznetsova *et al*. (1998), chromosome numbers in Fulgoroidea vary from 2n = 19 to 37 in males, and 2n = 28 + XO (39%), 2n = 26 + XO (27%), and 2n = 24 + XY (15%) are predominant. Emeljanov and Kirrilova (1989, 1991) presumed that in Fulgoroidea the initial karyotype was 2n = 30 in primitive groups and 2n = 28 in advanced group. Since 2n = 28 + XO represent the characteristic of Delphacidae (about 70% species examined in Delphacidae are of this type), and 2n = 24 + XY is obviously derived from 2n = 26 + XO by the translocation between the autosome and sex chromosome, we agree with Kuznetsova *et al*. (1998) that 2n = 26 + XO may be the ancestral karyotype in Fulgoroidea as a whole. Chromosome numbers among the superfamilies of the Auchenorrhyncha are often near a normal distribution. Although the predominant karyotypes are always found both in primitive and advanced groups, it can be understood that the predominant types means the primitive one.

The male reproductive systems and chromosome behaviors during meiotic prophase Ⅰ are very important taxonomic characters in Fulgoroidea. Testis follicle in Fulgoroidea is finger-like and enveloped by an orange sheath, which is very similar to those in Heteroptera, but in Cicadoidea, Cercopoidea, Cicadelloidea and Membracoidea, the testis without sheath and grape-like. Moreover, we have not found any sheathed testis in other homopteran insects except in Fulgoroidea. Meiotic prophase Ⅰ with a typical diffuse stage is another characteristic of Fulgoroidea. Diffuse stage was first described in aphids by Ris (1942), and also was observed in coccids, psyllids, Heteroptera by many other authors. In our opinion, the diffuse stage of male fulgoroids is very similar to those found in Psylloidea and Heteroptera.

By comparing studies on male reproductive systems

and the meiotic prophase Ⅰ, we agree to remove the Fulgoroidea out of Auchenorrhyncha (von Dohlen and Moran, 1995; Campbell *et al*., 1995; Sorensen *et al*., 1995). The relationship between Fulgoroidea and Heteroptera is much closer than that between Fulgoroidea and Auchenorrhyncha.

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中国 19 种蜡蝉的核型研究
(同翅目: 蜡蝉总科)

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摘要: 研究了中国 19 种蜡蝉的染色体数目、性别决定和染色体行为。2n = 28(26 + XO)被认为是蜡蝉科的原始核型特征。由于蜡蝉精巢具有被膜, 减数分裂前期Ⅰ具有弥散期, 因此作者认为蜡蝉与半翅目的关系更为密切。

关键词: 蜡蝉总科; 核型; 染色体; 减数分裂

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